

LITTLE BLUE BOOK NO. 1563
Edited by E. Haldeman-Julius

The Marvels and Oddities of Sunlight

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THE MARVELS AND ODDITIES OF SUNLIGHT

LIGHT IN RELATION TO TIME AND SPACE

In another study in this series, *How the Sun's Rays Will Give You Health and Beauty.*" the nature of the rays is explained and some of their marvelous manifestations described. Perhaps solely from a therapeutic standpoint, it is of little moment what light is. Certainly, primitive people, savages and even animals intuitively and instinctively seek and avail themselves of the healing qualities of sunlight without knowing or caring anything of the technical or physical elements involved in the rays. And millions of modern men, women and children seek and enjoy the balmy sunshine without giving a thought to the elusive properties of which it is comprised—or that propel it at unimaginable speed through the vastness of space.

Nevertheless, it is an ever-growing knowledge of the mechanism of the age-old mysteries of natural phenomena that enables us the better to control their influence, to modify it when advisable, and to increase their effectiveness and expand the field of their usefulness in human life. It is also by an *understanding* of the various manifestations of nature that scientists are enabled to duplicate, or even vastly to increase, the results by artificial means. Thus, ultra-violet rays—the curative and health-promoting elements of sunlight—can be produced by artificial radiation many times more powerful than those provided by

the sun in the form in which the solar rays reach the earth.

What, then, without going into a long and detailed technical description, is *Light*? One of the best and most tersely cogent definitions is that given by Sir Oliver Lodge, namely, that "Light is an electro-magnetic disturbance in the ether." The significance of this definition is brought home when we remember that light is projected through space at the rate of 186,326 miles per second and, coincident with its velocity, vibrates at the rate of from 38 billions to 400 billions per second, according to the character of the rays, from the infra-red to the ultra-violet, respectively. In a word, all the rays travel at the same speed, but differ widely in their rate of vibrations.

While alluding to the marvelous physical properties of light, it will be appropriate to consider for a moment the equally astonishing phenomena relating to the sources of light. The natural sources of light are the sun and the stars. These bodies are undergoing combustion and are therefore self-luminous. The sun gives off vibrations of the most varied nature and extraordinary complexity, all occurring in the omnipresent ether, and some not reaching the earth.

Sir Robert Ball, the English physicist, states that the sun pours forth its radiations with such prodigality that the earth is able only to intercept a two-thousand-millionth part of the whole. The intrinsic brilliancy of the sun's surface has been calculated to be 1000 candlepower per square millimeter, while a carbon arc lamp has a brilliancy of only 170

candlepower for the same area. Lord Kelvin estimated that every square foot of the sun's surface radiated energy at the rate of 7000 horse-power.

When we stop to think that there are millions of other suns in space, many of them far surpassing our sun in magnitude and luminosity, each of them simultaneously charging the ether with its bombardment of vibrations and rays, we begin to realize the importance of light as a factor in the universe.

The sun's rays, at the velocity above mentioned, reach the earth in about eight minutes and some seconds. All electro-magnetic waves travel a distance equal to eight times the circumference of the earth in a second.

We have some approximation of the size of our great source of light, the sun, when we recall that it is 865,000 miles in diameter (in comparison with the earth's 8,000 miles). Its mean distance from the earth is 92,930,000 miles. Light, as has been stated, bridges this immense distance in about eight and one-third minutes.

The apparent infinity of the universe becomes evident when we consider that light, traveling at the rate of 186,326 miles a second, takes years to reach the earth from many of the distant stars. These distances are termed "light-years" by astronomers. Thus, a single light-year is equal to almost six million million miles.

Alpha Centauri, the star nearest to the earth, is some four light-years distant from us. Only thirty stars are known to be within a hundred trillion miles of the earth.

The polar star is forty-four light-years away, and the five middle stars of the Plough are one hundred and eighty light-years distant from our planet. We occasionally see a star shoot in the firmament. What possibilities this suggests to us! Consider for a moment the seeming paradox represented in this complexity of time, light and space, in the following hypothetical, but reasonable and entirely plausible, phenomenon: We look out upon a beautiful, clear night and see a shooting star. If the star in question happens to be one in the neighborhood, astronomically speaking, of the quintette of the Plough, already referred to, it means that the actual phenomenon that *we have just observed* happened one hundred and eighty years ago—a quarter of a century before the American Revolution was fought.

Recently a star cloud has been found which is 700,000 light-years away, and in which some of the brightest stars are estimated to be about 30,000 times as luminous as our sun. Speculation regarding time and space here baffles the imagination and figures become so long that, as Mark Twain once said about certain German words, "they have a perspective."

ACTION OF LIGHT UPON THE BODY

It has been suggested that the curative power of sunlight, or of concentrated artificial light, may be due in part to the resistance of the tissues to light energy. It is an elementary fact of physics that whenever energy meets resistance at any point, heat is generated at that point—as, for instance, the heat generated by a gimlet boring through wood or other material,

or that generated by friction of any kind.

While the skin is a poor conductor of heat, it readily transmits light. In the tissues this light meets with resistance; otherwise it would be transmitted through the body. It is at the various points of absorption that the light rays are transformed into heat energy. Although this is written with special regard to visible light, the analogy is that in ultra-violet light the rays are transformed into chemical energy.

Sir Oliver Lodge said in his Huxley Lecture that light has a pressure, and that when it encounters an atom of matter an electron jumps out of the atom and the atom becomes ionized (photo-electricity), for the atom having lost an electric charge of one sign is now charged with the opposite sign. It is an ion. It is actively and chemically fierce, seeking to combine with another.* The ionization of mat-

*Ordinarily, when light is absorbed by a substance it is converted into heat, but under certain circumstances luminescence results—that is, there is an emission of light from the absorbing body. Luminescence includes photoluminescence, which in turn may be divided into fluorescence and phosphorescence, in both of which light of a certain wave-length falling on a substance results in the emission of light of a longer wave-length. If the luminescence exists only when the exciting rays are acting it is termed fluorescence. If it continues after the stimulus has ceased it is called phosphorescence. These phenomena are due to the motions of electrons separating from and recombining with their parent atoms. Janet Clark aptly describes the reaction as follows:

"In true photo-electric effect, the electrons are lost from the substance; in fluorescence they return to their original atom. In photo-chemical reactions they attach themselves to some other atom or group of atoms."

ter by light is becoming increasingly familiar in medical science.

Now, what are the chemical effects of light upon the skin? When the skin is exposed to light containing a sufficiency of ultra-violet rays, it gradually becomes red or brown. This is the familiar "sunburn" or "tan" so universally a souvenir of the summer vacation or week-end holiday at the seashore, or to a lesser extent in the mountains. It is also a normal acquisition in the winter sport centers in the high altitudes of Switzerland.

The pigmentation thus obtained is the result of melanin granules forming around the nuclei of the epidermal and the basal cells. When one leaves the exposed environment for a more sheltered one, the melanin deposit dissolves and the *sunburn* or *tan* tends to disappear.

Pigmentation is nature's protective measure against too bright sunlight. The more pigmented persons are, the less in general they suffer from the light rays. When the exposure is too drastic, prior to the formation of the protecting pigmentation, inflammation in greater or lesser degree, ensues. As a result, the skin burns and peels, and frequently there are severe blisters. Usually these are quite superficial and heal readily without forming scars, although the local inflammation affects the whole system, producing some temperature, sometimes great distress throughout the body, and in extreme cases provokes painful or even serious results.

It has been observed that Eskimos and polar explorers are poor in pigment at the close of the long polar nights. In this connection,

Shackleton remarked: "At the close of the night of four months' duration our faces were greenish yellow, but the sun soon tanned us again. Yet stranger was the discovery that the eyes of almost all of those which were brown and black became blue or gray during the long night."

Biologically, light explains the color of people and races. The nearer we approach the Equator, the darker are the inhabitants, and the farther we depart from the tropical centers the fairer mankind becomes. The more pigmented persons are, the less in general they suffer from light rays.

The physiology of the skin includes the functions of protection, sensation, heat, regulation and secretion. Tactile and thermal sensibility vary in different areas of the skin. The skin plays the principal role in regulating the amount of heat lost by the body through evaporation, radiation and conduction. In man, up to 85 percent of the total heat is lost by the body through the skin (Mayer). This regulation is effected through the blood vessels and their vasomotor nerves and the secretion of sweat.

The Negro receives heat through the skin, not only more quickly, but in greater quantities than does the white man, for the reason that his dark or black skin attracts and absorbs the heat, as dark colors tend to do generally. However, the Negro feels it less because, notwithstanding the fact that he does not possess more sweat glands than the white man, he sweats more readily (although not so profusely) and as a result, cools.

Aron noted that, at a time when the white man is perspiring over his entire body and the sweat dripping from his face and forehead, the brown man shows only a fine, velvet-like layer on his skin. The cooling effect is produced, not by the sweat that we see, but by the evaporated water that we do not see. Hypersecretion, or excessive sweating, is a disadvantage, as it deprives the body of water. The dark man has an advantage over the white in this economy of sweating.

The dark skin regulates the action both of the heat and the chemical rays. The energy absorbed by the pigment and converted into heat evaporates the water, so that the naturally pigmented skin of the Negro begins to sweat at a temperature at which the body still retains its heat.

Absence of pigment, even if it be only in isolated parts of the body, renders those parts especially sensitive to light. Albinos are very sensitive to light and are said to be "light-shy."

The pigmented skin is generally more resistant to infection and pathological conditions. Nipples with a delicate skin and poor pigmentation are very liable to sores in suckling women. Nature provides that the nipple areola becomes pigmented during pregnancy so as to lessen the disadvantages incident to suckling.

Skin well pigmented by sunlight tends to become firm and strong and at the same time delicate and soft, almost silk-like in texture. For this reason, Widmer recommends sun-

baths for cosmetic purposes, viz: "The skin of the parts of the body exposed to the light shows a tremendous increase in 'turgor.' After a short time it becomes 'full' and padded out, and wrinkles and corners are smoothed away. The whole individual is beautified," he writes, and this observation has been confirmed by others with sufficient experience in sunlight therapy to speak with authority.

THE PATHOLOGY OF SUNLIGHT

We have discussed various aspects of sunlight, emphasizing its unparalleled healthful properties and beneficial features. Furthermore, it is the source of heat and energy without which life on earth would be impossible. By way of comparison, it will be of interest to consider some of its pathological sides, as related both to human beings and animals. Surely this factor has a place under the oddities of sunlight.

Certain injurious effects of sunlight on the bodies of man and animals have long been known, such as sunstroke, heatstroke, sunburn and glacier-burn, etc.

However, investigations into light phenomena have disclosed a whole series of symptoms and diseases, formerly obscure, as falling into the pathology of light. It has been found that certain substances or agencies, either introduced into the body from without, or formed within the body, may render the organism acutely sensitive to light, so much so that it may suffer extremely from the effects of illumination.

These substances are called "light-sensitizers," and the corresponding diseases have been

termed "sensitizer illnesses." When introduced from without, the cause is known as "exogenous sensitizing." If the causative factors generate in the body itself, it is referred to as "endogenous sensitization."

Whereas excessive sunlight by heat radiation may cause severe general symptoms, and may even become dangerous, the injuries produced by the chemical rays are usually of a local nature, and affect chiefly the exposed parts of the skin or the unprotected eye.

The "sensitizer illnesses," on the other hand may not only cause severe general symptoms, but often actually continue on to "*light-death*," which has certain analogies to death from burns.

Heat stroke is a dangerous illness occasioned by the overheating of the body due to failure of the natural heat-regulators, the function of which is to keep the temperature of warm-blooded creatures within the limits of organic safety.

In heatstroke, the blood becomes thick and unable to circulate properly, owing, in the first place, to excessive sweating, and then to a sudden stopping of perspiration. The symptoms begin with a violent thirst and a dry burning skin, very red face, languor and headache. The patient is only able to speak haltingly and sluggishly, and then suddenly collapses and becomes unconscious. Death may quickly follow from stoppage of breathing or stagnation of the cerebral circulation—a true case of asphyxia.

Recurring to the group of diseases due to sensitization, both endogenous and exogenous,

a unique type of the former is called *porphyria*. Fortunately this is very rare, and is classified among the light-diseases. Porphyria leads to morbid changes, inflammation and necroses, but only in those parts *accessible to light*, on hands, head and especially the ears. Blinding, too, may result. It may also go on to severe disturbances of the nervous system. Before our knowledge of the influence of light had shown the true character of this obscure disease, it was often confused with syphilis and leprosy. In learning its real nature, there has been established the basis of a therapy.

Another less dangerous light affliction is summer rash. This disability is caused by the action of sunlight on predisposed persons, principally children. Its victims are mostly fair people. The first outbreak is characterized by the appearance of small, red, somewhat raised spots like flea-bites on the unprotected parts of the skin, such as the face, neck and hands, or on the naked feet and legs. Vesicles soon develop and these spots, with a center depression, much resembling a vaccine pustule. These vesicles dry up and a fine scar is formed under the crust. If the patient is *protected from light*, the eruption heals up in from two to three weeks. If not, he may suffer relapses for weeks. The trouble usually disappears in the winter, to reappear again in the spring, when the sun's rays gain in strength and effectiveness.

Prominent among the illnesses due to exogenous sensitiveness is the *chronic inflammation due to light*. This malady afflicts patients with

an idiosyncrasy to light, that is, they have a skin so sensitive to light that in the spring, as soon as the daylight becomes richer in chemical rays, they suffer from inflammation of the face, hands and every part where the rays meet the unprotected skin. This frequently leads to chronic eczema. Inflammation of the eyes is often a further symptom. These rashes disappear when the patient is *confined in a dark room*, and in those months which are poor in sunlight, to reappear again in the spring. The sensitiveness usually becomes greater as the patient grows older.

Certain foods also play a part in the illnesses due to light. Pellagra, for instance, is caused primarily by the consumption of unripe or damaged maize. This disease is accompanied by severe disorders of the nervous system continuing to pronounced psychoses and gradual decline of mental power. Furthermore, the skin is raw, fissured and scaly, symptoms which have given the affliction its name. These lesions occur principally on the parts of the body exposed to sunlight, and are especially noticeable in the summer months when the people among whom it is prevalent work in the fields. In the foggy winter months, as has been observed in the plains of Lombardy, the skin troubles abate.

It is assumed that the predisposing cause of pellagra is an absence or deficiency of vitamins in the maize consumed. The same applies to *beri-beri*, a general chronic disease occurring quite exclusively among people whose staple diet is polished or devitalized rice. Vitamins, in the last analysis, are really the chem-

ical properties of sunlight that have been absorbed by vegetation and which we obtain either directly from the latter source, or indirectly from animal foods, from the vegetation which the animals eat, and to an extent from the effects of the solar rays upon their bodies.

Vitamine D, in fact, has been described as the "sunshine vitamine." In the annual report of the British Medical Research Council, an account is given of the successful production of this vitamine by synthetic processes. Of Vitamine D, the report says that it is "of unknown chemical nature and till lately obtained only as a product of living substances—by the action of the ultra-violet of the sunlight upon a definite chemical substance." It is now synthetically produced by the use of ultra-violet light acting upon a substance known as ergosterol. Vitamine D is, with Vitamine A, an essential element of food, a substance which cures rickets and other ills and assists in the development of teeth, bone and muscles. There is, however, a deficiency of it in many foods, particularly those subjected to the various refining processes in the course of preparing them for the market. It is expected that the irradiated ergosterol will be available for mixing with foods that are deficient in Vitamine D, or even used in pellet form when required.

Buckwheat disease (fagopyrism), a disease of domestic animals such as cattle, sheep and pigs, presents analogies with pellagra. It is evidenced by an eruption in animals fed on buckwheat. A peculiarity of this disease, significant in our present study, is that it is only contracted by white animals. Pigmented or

dark ones are immune, and in piebald animals, the eruption is seen only on the light-colored places. Furthermore, by keeping the animals in dark stalls, they are protected against the disease or cured if attacked. It is assumed there is some substance in the buckwheat which acts as a poison in the light. White rabbits, rats and mice, whose skin admits much light, can be made very ill, even fatally, by feeding them on buckwheat in a *bright light*, while colored, black or gray animals are much more resistant.

Bernhard relates an interesting example of the curious effect of light, plus a certain substance, upon barley fed to cattle. In order to distinguish barley for cattle food from barley for brewing, the German Government decided some years ago to color the barley for cattle food. Eosin was used for this purpose. Previously, extensive feeding experiments were made by the Governmental Health Office to demonstrate the innocuousness of such a coloring matter. These experiments were conducted on stall-fed animals only, but the matter worked out differently in practice, and it became plain that some animals fed with eosin barley became seriously ill. This was not due to direct eosin poisoning, but to the *injurious effect of light aggravated by eosin*. It was found that only those animals became ill which were exposed for a long time to direct sunlight, while the animals kept in stalls escaped.

SUNLIGHT STARVATION

On the surface, it may seem rather far-

fetched to allude to "sunlight starvation" as a condition that periodically undermines the health and well-being of countless numbers of peoples in the Northern temperate zone. Notwithstanding occasional cloudy and stormy weather, there would seem to be a goodly number of bright and clear days, to which the great majority of our people have fairly free access.

However, from November to May, there is so great a reduction in the short-ray radiations that reach the earth in the Northern latitudes that a very considerable proportion of the general population of these parts may truly be said to suffer from "sunlight starvation."

The factors involved are extremely complex. In conjunction with the lessened radiation, there is greatly increased dampness. It is the time of the year when we are more than ever exposed to the dangers of our unseen but omnipresent enemies—bacteria. Abundant sunlight is the greatest destroyer of germ life that preys upon man. And as the winter progresses our resistance, due to lack of effective sunshine, diminishes so that by March we reach the point of greatest mortality.

It has been estimated that if a person were to expose himself to full sunlight for a whole year in the latitude of New York City, he would receive only 384 hours of adequate vitalizing radiation. Therefore, if one were in a position to live out of doors the whole year round, the actual amount of sunlight received would be less than might be anticipated, although, of course, it would be ample, considering the capacity of the human mammal for ad-

justing and adapting himself to his environment.

But instead of living any appreciable part of the time under the advantages of direct sunlight, we are an indoor people, and constantly becoming more so—living, working, sleeping, eating and even enjoying our amusements (as witness the movies, theater, home radio entertainment, etc.) indoors.

Then, not content with shunning the sunlight for the major part of our time, custom and tradition decree that we shut out solar radiation from all but a few square inches of our bodies when we do get a brief respite to enjoy the vitalizing rays of Old Sol.

We have already observed that the skin of our whole body is marvelously constructed to receive, absorb and make internal use of the chemical rays of the sun. Our skin is a delicately adjusted laboratory for selecting and utilizing the vital solar radiations, and adapting their energy to the use of the whole organism. But to the detriment of our health and well-being, we attempt to thwart this mechanism which covers every square inch of our body. We prevent its free normal functioning by shrouding it with layers of unnecessary and often ugly clothes, literally barricading our bodies against the sun.

Civilization has meant the building up of congested areas where little or no provision has been made for sunlight, and in latitudes where the sun is radiantly ineffective for many consecutive months of the year, where smoke, soot and dust pollute the air and act as a barrier of the vitalizing rays when meteorological

conditions are favorable. To a very great extent, modern man has fled from the sun which is the source of all that makes life possible, and has literally slunk into the shadows that breed sickness and premature death.

Considering these phases of the problem, we can readily understand that "sunlight starvation" is no fancy figure of speech, but a very real danger and a widespread menace to millions of people.

The Public Health Report of March 6, 1928, states: "Industrial workers possess less resistance to respiratory infections toward the end of the winter than at the beginning." In a two-year test of workmen in a large factory it was found that a lag in production began each year late in October, became greatest in mid-winter, and gradually diminished until May, when it became normal again.

Thus the comparatively sunless winter days, indoor occupations, the use of excess clothes, and other factors in modern living, contribute to our lowered vitality in winter, and consequent lowered resistance to disease.

William J. A. Bailey reminds us that California, which gets more effective sunlight than any other portion of this country, has the most luxurious flowers, the best fruits and the largest trees. The draft board statistics showed that the best developed men came from the Pacific Coast region, where the pure sunshine, the great open spaces and more natural mode of life, combined to produce the finest specimens of physical manhood.

And sunlight starvation affects the taste and nutrition value of foods just the same as it

works havoc upon man and animal. Flour may be so treated as to lose its inherent quality to produce growth. If, under these conditions, it is exposed to sunlight or to artificial ultra-violet radiation, the growth-producing properties return.

Cod-liver oil is less valuable when collected at certain times of the year than it is at other times, but if the seasonally poor oil is subjected to ultra-violet radiation; it gains in growth-producing power and it may even surpass the choicest natural supply in this respect. Much more powerful and effective ultra-violet rays can be produced by artificial radiation, particularly from the quartz mercury lamp, than can be obtained from the sun under the most favorable conditions.

Luckiesh and Pacini cite the interesting case of the home-made spaghetti as an illustration of the effect of sunlight on a plain, widely used food staple. It was customary in the downtown districts of New York City some years ago for the Italians to make spaghetti in their homes. Flour and water (occasionally eggs were used, but in the poorer sections this was not the rule) were made into a dough and finally rolled out into spaghetti or cut up into noodles. The spaghetti or the noodles were looped over broom handles and placed out on the fire-escapes to dry. It seemed as if the dwellers in the densely populated tenements had tacitly agreed to reserve a part of the week for spaghetti drying, and the remainder of the week for hanging out the family wash. Hundreds and hundreds of fire-escapes festooned with noodles could be seen along certain streets on

bright sunny days during the latter part of the week. This home industry soon grew so as to exceed the demands of the immediate family and a market was thereupon established for home-made noodles and spaghetti. The industry was patronized by a great many people, some of them Italians living in other sections of the city.

In the course of time fire ordinances were enacted which, after the spaghetti industry had attained considerable momentum over years of progress, prevented the tenement dwellers from keeping anything of an obstructive nature on the fire-escapes, and those who continued the home manufacture of the pastry were compelled to resort to indoor drying.

Within a very short time after the change from outdoor to indoor drying took place, numerous complaints were registered against the quality of the noodles, the veteran spaghetti eaters alleging that they noticed a marked depreciation in the nutritive value and taste of the product. The loss in nutritive value sensed by the consumers was styled as a loss in the "satisfying" quality of the product, which was partly compensated for by increasing the amount eaten, though in most instances the disappointed customers sought imported spaghetti which was for the most part dried in open sunlit areas.

No one at that time was willing to concede that there could be a difference in the nutritive quality of the two products, especially since the ingredients entering into the pastry had not been changed and there had been no changes in the mixing methods. Only the

method of drying had been altered. But this apparently slight change had meant the vast difference between a wholesome, satisfying food staple and one that was devitalized and unsatisfying. What happened to the Italian spaghetti eaters of Manhattan at that time is happening today to millions of Americans who depend largely upon devitalized, prepared and refined foods as their chief source of nutrition. Babies and children fed largely on prepared foods are among the chief sufferers.

It has been observed that rickets, a widely prevalent constitutional disease of childhood, involving the bones in particular and frequently resulting in minor deformities is invariably caused by an insufficiency of ultra-violet rays—another way of saying “sunlight starvation.” Normally these rays are obtained by adequate exposure of the body or of parts of the body, to direct sunlight, plus a diet that includes a certain requisite of vitamins. Vitamins, we have already seen, are forms of solar energy which we obtain principally from vegetation, although some parts of the animal which serves as food, such as the liver, etc., are particularly rich in them.

Insufficiency of ultra-violet light deprives the whole organism in general, and the bones in particular, of some of its essentials to health and vigor. Now, as the red corpuscles, the hard-working food and oxygen carriers of the blood, and the white corpuscles, the tenacious germ fighters of our organism, are made in the marrow of bones, it is evident when the bone structure is deficient in certain essential ma-

terials, that the blood and the body as a whole must suffer. So the effects of sunlight starvation form a vicious circle.

THE MARVELS OF SUNLIGHT THERAPY IN THE ALPS

A treatise, however brief, on sunlight and its therapy would not be complete without some account of the epoch-making work of Rollier, Bernhard and their co-workers in this field.

The Alps are especially favored with many natural advantages as the location for solar sanatoria, and the choicest sites come close to the ideal. Even the relative disadvantages of the cold winters is compensated for by the atmospheric calm and the equable radiation of the sun, as well as the dryness of the air, so that patients taking the sun-treatment are able to maintain their bodily temperature at the proper level without difficulty. The peculiar advantages of the Alpine climate may be summarized briefly as follows:

1. Low atmospheric pressure.
2. Marked dryness and purity of the air.
3. Infrequent winds. Wind-protected places are easily found in the mountains, and especially on the Southern slopes, which are a guarantee against the cold North winds.
4. Such mists as occur are slight and of short duration. They become less and less frequent at altitudes ranging between 1200 and 1500 metres. The inhabitants of such parts enjoy months of the most glorious sunshine in winter, while below them stretches a sea of mist which surrounds the lower levels with cold and darkness.

5. Long periods of rain, such as are familiar to the inhabitants of the valleys, are quite exceptional in the high mountains.

6. The duration of sunshine is much longer at the high altitude as compared with the flat country on account of the relative scarcity of mists. This difference is particularly striking in the winter months. As an illustration, during the four months from November to February the hours of sunshine are exactly double at St. Moritz (1856 m.) what they are in Zurich (411 m.).

Dorno estimates that while from one-quarter to one-third of the rays become lost on the heights of the Alps, more than half of them are lost in the valleys. With a low sun and a damp air, only 14% of them gain access to a city like Washington. Of this waste, one-half is caused through the permanent atmospheric gases and the other half through water vapor.

7. The intensity of light is remarkably great in the Alps. In the winter this is increased materially by the reflecting properties of ice and snow. This accounts for the phenomenal bactericidal capacity of sun rays in the Alpine country. Comparative studies made in Davos (1560 m.), Wald-Zurich (903 m.) and in Lenin-grad (sea-level), showed that in Davos three hours, in the wood four, and by the sea five hours were required, respectively, to kill tubercle bacilli by means of sun rays.

8. The intensity of the heat rays also is very considerable. A rise of the thermometer up to 50° (C.) in the sun, even in winter, is nothing out of the ordinary, while in the shade

little more than the freezing point is registered at the same moment.

9. There is conspicuous radio-activity of the atmosphere. This is enhanced in the high mountains. Saake demonstrated that the air in Arosa (1800 m.) contained on an average three times as much radio-active emanation as was found in Wolfenbuttel (75 m.) by the same methods. The maximum content may in fact occasionally become five times greater than in the lowlands.

Dr. Oscar Bernhard was the first of the great modern exponents of heliotherapy to exploit the natural sunlight of the Alps. He made use of it in his hospital at Samaden, in the Engadine, for the treatment of surgical wounds, in 1902. This he later extended to his private clinic at St. Moritz. It was the Swiss butchers' custom of curing meat by sunlight that suggested to Bernhard that a similar desiccation might also be employed on living tissue. He tried it out on the suppurating abdominal wound of a patient, and the healing was so remarkable that other wounds were treated in the same manner. Thus was born, or reborn, the modern science of heliotherapy. And like many other important and enormously valuable discoveries, it was the result of the thoughtful observation of a commonplace incident.

In 1903, Dr. A. Rollier, unaware of the work of Bernhard, opened at Leysin (French Switzerland) his world-famous clinic for the systematized sun treatment of surgical tuberculosis. Rollier's method of treatment begins by exposing the patient's body to the rays of the sun for

periods of from five to ten minutes. Usually the new patient's feet are exposed for five minutes twice or three times the first day, for ten minutes the second day, and so on. The legs are exposed for five minutes twice or three times the second day, ten the third day, etc., until in about two weeks the entire body is exposed for from three to six hours daily. The prescription of sun exposure for each patient is an individual calculation, and many factors, such as altitude, humidity, the angle at which the principal ray strikes the patient, as well as the sensibleness and age of the patient have all to be taken into consideration.

Rollier has achieved such success in the treatment of some tubercular conditions of the extremities that limbs which other surgeons had advised amputating were restored to use. The proportion of cures effected under Rollier's treatment ranges upward of ninety per cent of the cases he receives, and this is all the more remarkable when we consider that the great majority of them are in advanced stages, coming to him as a last resort after having tried, unsuccessfully, various other forms of treatment. They come to him from all parts of the world.

Dr. Rollier has demonstrated the practical truth of Carre's contention that "heliotherapy, combined with the open-air cure at high altitudes, heals tuberculosis in all forms, in all stages, and at every age, provided it be used long enough."

C. W. Saleeby, the English medical writer, states that after a day at Leysin one gains

an entirely new respect for the skin. "This admirable organ, the natural clothing of the body, which grows continuously throughout life, which has at least four absolutely distinct sets of sensory nerves distributed to it, which is essential in the regulation of the temperature, which is waterproof from without inwards, but allows the excretory sweat to escape freely, which, when unbroken, is microbe-proof, and which can readily absorb sunlight—this most beautiful, versatile and wonderful organ is, for the most part, smothered, blanched and blinded in clothes, and can only gradually be restored to the air and light which are its natural surroundings. Then, and only then, we learn what it is capable of."

The effect on the skin of controlled and regulated exposure to sun and air is astounding to those who have never before seen the results at first hand. Properly aired and sunned, the skin becomes a velvety, supple, copper-colored tissue, absolutely immune from anything of the nature of pimples or local inflammation. What is even more remarkable is that the muscles keep firm and well-developed under the supple skin, even in the case of those patients who have, in many instances, not moved—practically speaking—in months. Nor have they been massaged.

"Light," Dr. Rollier declares, "is the best masseur." At any rate, we find that the stimulating light, playing upon the nude skin in the dry, cool air, induces and maintains that condition of tone in the muscles which without moving any joints, is yet a form of muscular

activity essential for the production of bodily heat and for the proper posture of the bodily parts. As a result, plaster of Paris casts are as alien as the knife in Rollier's treatment of surgical tuberculosis.

Contrary to the traditional treatment of tuberculosis, Rollier prescribes a very plain and light diet. It seems to be, as some authorities suggest, that the solar energy absorbed by the body through the skin becomes part of the bodily energy that is ordinarily obtained from the food that is eaten. This theory has received confirmation in the work of Sonne at the Finsen Medical Light Institute in Copenhagen. It implies that when radiant energy is contributed directly to the energy of the body through the skin, there is much less need to burn up fats and carbohydrates in order to keep the blood warm. In a very real sense, then, light may be said to be a food that builds up the whole organism and saves the digestive mechanism. Thus, the patients at Leysin, whose diet is severely moderate, are perhaps to a very considerable extent living on light, much in the manner that green plants do, and are therefore not so much in need of feeding upon the food produced by vegetation in the same manner.

As has been stated, no arbitrary rules can be laid down governing the conditions for insolation. There are always the exceptional cases, and individual idiosyncracies are so varied that there are personal adaptations to be made in the great majority of instances. However, there are representative types of individuals

that are indicated by their common characteristics, which offer more than a hint to the trained heliotherapist.

Rollier found, for instance, that Venetian blondes, as a rule, react very strongly to sunlight, so much so that from the first the parts to be exposed are covered with gauze in order to prevent burns. This class of patient readily develops a form of "sunstroke," which frequently leads to slight though unpleasant and painful complications, tending to discourage them, discredits the treatment and, owing to interruptions, prolongs it considerably.

It has been pointed out by Bernhard that now and then one sees fair patients who pigment excellently with the sun-bath, but the family history in these cases always shows that among their forebears dark individuals occurred—in other words, they possess an hereditary disposition to pigment.

As an indication of proper treatment, it may be set down as a general rule that a sun-bath should produce in everyone the sensation of comfort and well-being, followed by the sensation of increased strength. Fatigue, vertigo, excitation or any unfavorable response indicates a faulty method of insolation—at least one not adapted to the individual in whom such a reaction takes place.

The psychic make-up of the patient must not be overlooked. Some patients display such an exaggerated enthusiasm for the sun-cure that they would over-expose themselves to the sunlight, resulting in inflammation or congestion, if not carefully supervised. It is necessary to

restrain this type of person; while others with a certain nervous hesitancy have to be encouraged to hold out, in the beginning, until their system and particularly the skin becomes adjusted to the radiation.

It will be noted that Rollier lays emphasis on the element of time as an integral part of his treatment. It was this which lead him to select the secluded fastnesses of the Alps, with their incomparable natural advantages that have been outlined, thus assuring consistent all-the-year-round treatment. Therefore, an uninterrupted cure became possible in even very extreme and advanced cases because a transformation of the whole organism could be effected, in addition to complete repair of tubercular bone and joint foci.

While on the subject of Alpine light, it will be pertinent to mention some of the peculiarities of vegetation due to the influence of the unusual solar emanations in the Alpine regions. In the first place, nowhere does the influence of light on growth and vital functions manifest itself in such an obvious manner as in the vegetable kingdom. By the same token, we possess a much more accurate knowledge of the biological processes by which energy of the sun's rays is utilized in the vegetable than in the animal organism. The nourishment and harmonious development of the plant depends chiefly on light.

Plants grow toward the light. They often possess the faculty of turning certain parts to the light, and become better developed on the side from which they obtain their light. All

these movements of orientation which are caused through one-sided lighting or through differences in the amount of light received are summarized under the name of *heliotropism*.

In many Alpine shrubs, the creeping Alpine heather, for example, the stems and branches go out of their way to attach themselves to the surfaces of stones and rocks, which radiate the sun's heat and which they receive, so that the plants form a kind of trellis work. This attraction to heat is termed *thermotropism*. It is, however, so closely related to heliotropism, both in its biologic motive and its effects, that it may be considered a phase of the same thing.

Light has a pronounced influence on the generative organs of plants. It is well known that the organs, that is, the flowers and the fruits, are produced much less prolifically when a strong vegetative growth of leaves and stalks takes place; or, as is commonly said, when the plants "run to leaves."

A comparison of the inhabitants of the sunny and shady slopes of the Alpine country offers some interesting observations, and shows in a very concrete manner the influence of sunlight on human life. On the sunny side, among other villages is the community of Ausserberg, and on the shady side are situated the villages of Birchen and Unterbach. Stebler, who has made a study of these people and their environment, makes the following suggestive statement:

"The people on the sunny side are tough and hardy from wind and weather, sun and work.

They are stronger and less liable to diseases than the inhabitants on the opposite side of the valley; that is, on the shaded hill on which are situated the villages of Birchen and Unterbach. This is because they are invigorated by the direct rays of the sun.

"Formerly the dwellers of both the shaded and the sunny slopes went together to church, and those who died on both sides of the valley, viz., Ausserberg on one side and Birchen and Unterbach on the other side, had to be buried in St. Germain, and it has been said that the bodies of the 'sunnysiders' decomposed much more slowly than those of the 'shadysiders.' It thus comes about that the greater power of resistance of the former is seen even in the grave."

In any event, this observation is explainable on physiological grounds, for the remains of plants, animals and men which are watery decompose more quickly than those which are drier. We are also reminded of the keeping qualities of Alpine sun-dried flesh—which was the inspiration of Bernhard's system of heliotherapy, much the same as the falling apple was the inspiration of Newton's theory of gravity.

Indeed, there seems to be no phase or condition of life—however high or low in the organic matter—that does not offer some graphic illustration of the marvels and oddities of sunlight.

